Using *C. elegans* for an Independent Inquiry Lab

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Lab Learning Goals

- Gain experience in research design
- Enhance reading and analysis of primary literature
- Provide technical experience with a model organism

Class

- 16-20 students
- Sophomores-seniors
  - Introductory Biology and Chemistry
Lab Learning Objectives

- Gain experience in experimental design
- Demonstrate proficiency in interpreting and analysis of data
- Demonstrate gains in scientific communication, information literacy, and formative failure
Flow Chart

Activities
- C. elegans
- Journal Clubs
- Lecture
- Guest Lectures

Skills
- How to search the literature
- How to read 1° and 2° literature
- Experimental Design
- Data analysis
- Critical thinking
- C. elegans model
- Formative failure

Independent Project
- Read & Analyze 1° and 2° literature
- Generate a hypothesis
- Design experiments
- Predict & Analyze results
- Redesign

Experiments
- C. elegans
  - Basic Handling
  - Dose Response (i.e., brood size, locomotion)
- Chemotaxis assay
- Reproductive assay
C. elegans

- Minimal training for instructor
- Cheap and easy to maintain
- Stereotypical behavioral and morphological characteristics
- Amenable to toxicological manipulations

https://www.wormatlas.org/hermaphrodite/introduction/mainframe.htm
Equipment

- Stereo dissecting microscope
- Alcohol lamp
- Incubator (20°C and 15°C)
  - Room temperature works too!
- Ability to culture bacteria
Familiarity with Model and Worm Handling (~1 wk)

- Read and discuss paper on *C. elegans* as a model
- Become familiar with worm culturing
  - Identifying
  - Picking
Dose-Response, Chemotaxis, Brood Size (~2-3 wks)

- Read relevant primary literature each week.
- Instructor designed and student designed
  - Data analysis
  - Present and explain results to the class
Possible Assays (Dose-Response and Brood Size)

- Number of progeny
  - Fertility
  - Dose or mutant

Average Brood Size

WT strain is more sensitive to Cd.

Am130 mutant strain has reduced brood size.
Possible Assays (Chemotaxis)

- Chemical or Dose

![Chemotaxis Index Diagram](image)

<table>
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<th>Assay</th>
<th>Chemotaxis Index</th>
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<tr>
<td>Control</td>
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<tr>
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<td>-1 ± 0.5</td>
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<tr>
<td>cAMP</td>
<td>1 ± 0.5</td>
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- Possible Assays:

  - T1
  - C1
  - C2
  - T2
Design an Independent Experiment (~2 Weeks)

- Develop an assay to measure an effect on worm biology
  - WT, Mutant, dose
  - Write a proposal supported by literature
- Perform assay
- Analyze and present results
  - Formative failure
Repeat Independent Experiment (~2 Weeks)

- Adjust based on previous results
- Perform assay
- Analyze results
- Write an abstract and present results
Student Survey Results

- **Skill in the interpretation of results**: No gain or very small gain (4), Moderate gain (1), Large gain (10)
- **Tolerance for obstacles faced in the research process**: No gain or very small gain (5), Moderate gain (1), Large gain (8)
- **Ability to analyze data and other information**: No gain or very small gain (2), Moderate gain (5), Large gain (8)
- **Ability to read and understand primary literature**: No gain or very small gain (3), Moderate gain (6), Large gain (5)
- **Skill in how to present data orally**: No gain or very small gain (1), Moderate gain (6), Large gain (3)
Student Survey Results

- No gain or very small gain
- Moderate gain
- Large gain
- Prefer not to answer

Skill in science writing: No gain, Moderate gain, Large gain
Self-confidence: No gain, Moderate gain, Large gain
Learning to work independently: No gain, Moderate gain, Large gain
Becoming part of a learning community: No gain, Moderate gain, Large gain

Number of Students

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Overall Conclusions

- *C. elegans* are an easy and cost-effective model for undergraduates
- Students become more comfortable with searching and analyzing the literature
- Lab introduces research methods and concepts in toxicology
- Students present their work in written and oral form
References

• Wormbook.org